Wednesday

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Interlaboratory comparison of polarization crosstalk measurement methods in terminated high-birefringence optical fiber

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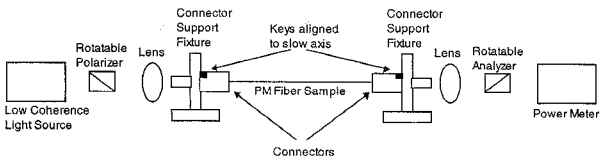
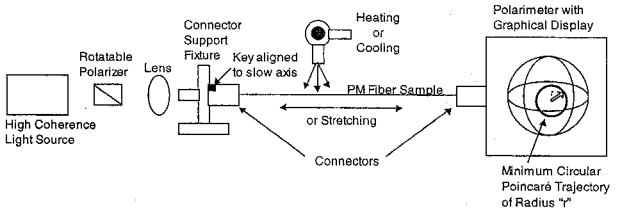
At the request of the Telecommunications Industry Association (TIA), NIST and four separate industrial participants have completed a preliminary interlaboratory comparison of two polarization crosstalk measurement methods for connectorized PM fiber. The traditional method makes use of standard optical polarization components. It will soon be considered a standard fiber-optic test procedure (FOTP). The other method is more recent and employs the capabilities of real-time polarimeters with a graphical polarization state (Poincaré sphere) display. It has been proposed as an alternate



WM3 Fig. 1. Traditional cross talk measurement. The source must be depolarized or circularly polarized. The input polarizer and output analyzer are adjusted sequentially to obtain maximum throughput power which is measured. Next, the analyzer is then rotated to sample the minimized orthogonal state power which is also measured.



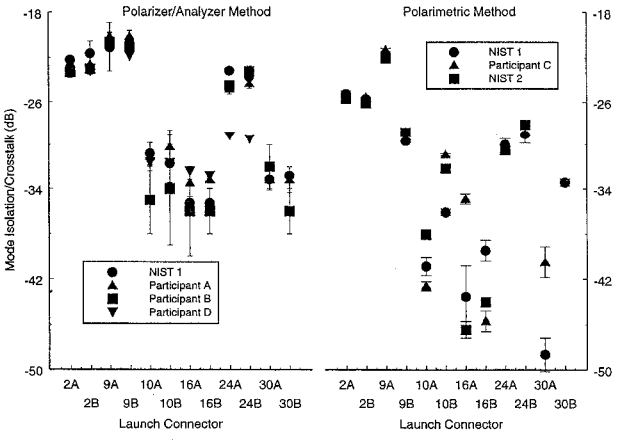
WM3 Fig. 2. Alternative cross talk measurement. The source must be circularly polarized. After the input polarizer is adjusted to obtain maximum throughput power, the PM fiber sample must be stressed to generate a circular Poincaré trajectory. The input polarizer is then readjusted to minimize the radius, which is then obtained from a fitting circle following the measurement.

FOTP for those with the appropriate capabilities. The correspondence between the two methods was evaluated using a set of six nominally identical 2 m PM patch cords as test devices. They are single mode at 1550 nm and terminated with FC/PC style connectors with a range of termination qualities. This quality was reflected in the polarization crosstalk (PCT). These measurements show some disagreement between the two methods.

The first technique, the polarizer/analyzer method, is shown in Fig. 1. Once the power coupled into the fiber has been maximized, the polarizer and analyzer are alternately adjusted to obtain maximum throughput. The analyzer is then adjusted approximately 90°, to the orthogonal polarization state, to obtain the minimum throughput. The polarization crosstalk inherent in the fiber/connector combination is then

$$PCT = 10\log\left[\frac{P_{\min}}{P_{\max}}\right](\mathrm{dB}). \qquad (1)$$

The second technique, the polarimetric method, is shown in Fig. 2. Once the coupled power has been maximized, the linear polarizer is rotated to minimize the radius of the circular trajectories traced out on the Poincaré sphere by fiber path perturbations. Perturbing PM fiber by either stretching or heating alters the phase relationship between the signal components propagating along the principal axes and thereby induces a systematic change in polarization state. A full 2π rad displace ment in phase produces a complete circle on the Poincaré sphere with radius, r, related to the degree of alignment to a principal axis.



WM3 Fig. 3. PM fiber mode isolation/cross talk comparison between NIST, HP Lightwave Operation, Corning Inc., and the 3M Company - Minneapolis and Austin Sector Laboratories.

The polarization crosstalk is given by

$$PCT = 10\log\left[\frac{1 - \sqrt{1 - r^2}}{1 + \sqrt{1 - r^2}}\right](\mathrm{dB}). \quad (2)$$

The interlaboratory comparison results are shown in Fig. 3. To the extent possible, each participant followed the current form of the FOTP written for each method. For each method, the data are displayed for each launch connector. Among the polarizer/analyzer results, for cross talk higher than −23 dB, scatter is within approximately ±5% of the averages with one exception. Participant D measured two values roughly 4 dB lower on cable 24. Cross talk values that cluster about −35 dB are within approximately ±10% of the averages. Within the polarimeter results, values higher than −30 dB scatter within approximately ±5% of the averages. For values below −30 dB, scatter rises to approximately ±15% of the averages due, possibly, to limitations on source coherence. Comparing the two methods against each other for each launch connector, however, yields variations as low as 5% for connector 9A but as high as 30% for 9B.

In conclusion, we present data that indicates some disagreement between two different methods of measuring polarization crosstalk in terminated PM fiber. The reason is not yet known but will continue to be investigated.